L-700

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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PRESSURE-DISTRIBUTION MEASUREMENTS OF TWO AIRFOIL MODELS WITH FOWLER FLAPS SUBMITTED BY CONSOLIDATED AIRCRAFT CORPORATION AS ALTERNATIVE WING SECTIONS OF THE XB-32 AIRPLANE

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

MEMORANDUM REPORT

for

Materiel Division, Army Air Corps

PRESSURE-DISTRIBUTION MEASUREMENTS OF TWO AIRFOIL MODELS WITH FOWLER FLAPS SUBMITTED BY CONSOLIDATED AIRCRAFT CORPORATION AS ALTERNATIVE WING SECTIONS OF THE XB-32 AIRPLANE

By Ira H. Abbott

INTRODUCTION

Pressure-distribution measurements were made at the request of the Materiel Division, U. S. Army Air Corps, on two 24-inch chord models equipped with Fowler flaps and submitted by the Consolidated Aircraft Corporation. The tests were made in the Langley two-dimensional low-turbulence pressure tunnel.

The two models represented sections of the CAC wing and of the low-drag wing for the XB-32 airplane. The models are described in reference 1. Similar tests were made of a third model representing a section of the Davis wing for the same airplane and the results were reported in reference 2. The same flap was used for tests of the CAC and Davis wing sections. The pressure-distribution tubes for the orifices in the flaps for all models were removed for the tests of reference 1 to prevent possible interference with the flow through the slot. These tubes were replaced for the pressure-distribution tests on the Davis and CAC sections in essentially the same manner as when received except that smaller diameter tubes were used to minimize possible interference effects. More time was available for replacing the tubes on the flap for the low-drag section because this model was tested last, and the tubes were brought out of the flap on the lower surface near the flap end in such a manner as not to interfere with the slot.

RESULTS AND DISCUSSION

Pressure-distribution diagrams for several angles of attack and flap deflections of 0°, 20°, and 40° are presented in figures 1 to 16 for the section of the CAC wing and in figures 17 to 32 for the section of the low-drag wing. Pressure-distribution diagrams obtained at three angles of attack of the low-drag wing section are presented in figures 33 to 35 for a flap deflection of 30° with the flap leading edge under the lip and a slot of 0.021c (reference 1). At least a part of the unfairness of some of the diagrams may be attributed to the effects of orifices not being exactly flush with the model surface.

Pressures are plotted directly as obtained from the manometer in terms of $\frac{1}{2}$-inch units of carbon tetrachloride. The abscissa is the projection on the chord line of the pressure orifices. The values of the corrected dynamic pressure q and the impact pressure level in terms of the same units are given on each figure. The static pressure level is obtained by adding the value of q to the impact pressure level. The value $\left(\frac{v}{V}\right)^2$, where v is the local velocity and V is the free-stream velocity, is obtained by dividing the local pressure, measured from the impact pressure level, by the value of q.

The normal-force coefficient as obtained by integration of the pressure diagrams is given on each figure. These normal-force coefficients are in reasonable agreement with the lift coefficients presented in reference 1. At each flap deflection, the pressure distribution presented at the highest angle of attack was obtained at or close to maximum lift.

Moment coefficients about the quarter-chord point are also presented as obtained by integration of the diagrams. These moment coefficients do not contain the component of moment associated with the chord force which may be appreciable, especially for the flap-deflected conditions. This component of moment may be obtained by replotting the diagrams against displacement of the orifices perpendicular to the chord. The pressure diagrams with flap deflected have been joined to close the pressure diagrams for the flaps. Flap forces and moment may be obtained from these diagrams and replots made with respect to the desired reference lines.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., January 29, 1942.

REFERENCES

1. Abbott, Ira H., and Turner, Harold R., Jr.: Lift and Drag Tests of Three Airfoil Models with Fowler Flaps Submitted by Consolidated Aircraft Corporation. NACA MR, Dec. 29, 1941.

2. Abbott, Ira H.: Pressure-Distribution Measurements of a Model of a Davis Wing Section with Fowler Flap Submitted by Consolidated Aircraft Corporation. NACA MR, Jan. 17, 1942.

Section of C.A.C. Wing
24-inch chord
Flap retracted
Angle of attack, -2.0°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = -.095$ $c_{m_{c/4}} = -.019$

LOWER

UPPER

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Figure 1

y/c

x/c

48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10

0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1 1.2

1/2" CC/4

Section of C.A.C. Wing
24-inch chord
Flap retracted
Angle of attack, 0°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = .132$ $c_{m_{c/4}} = -.024$

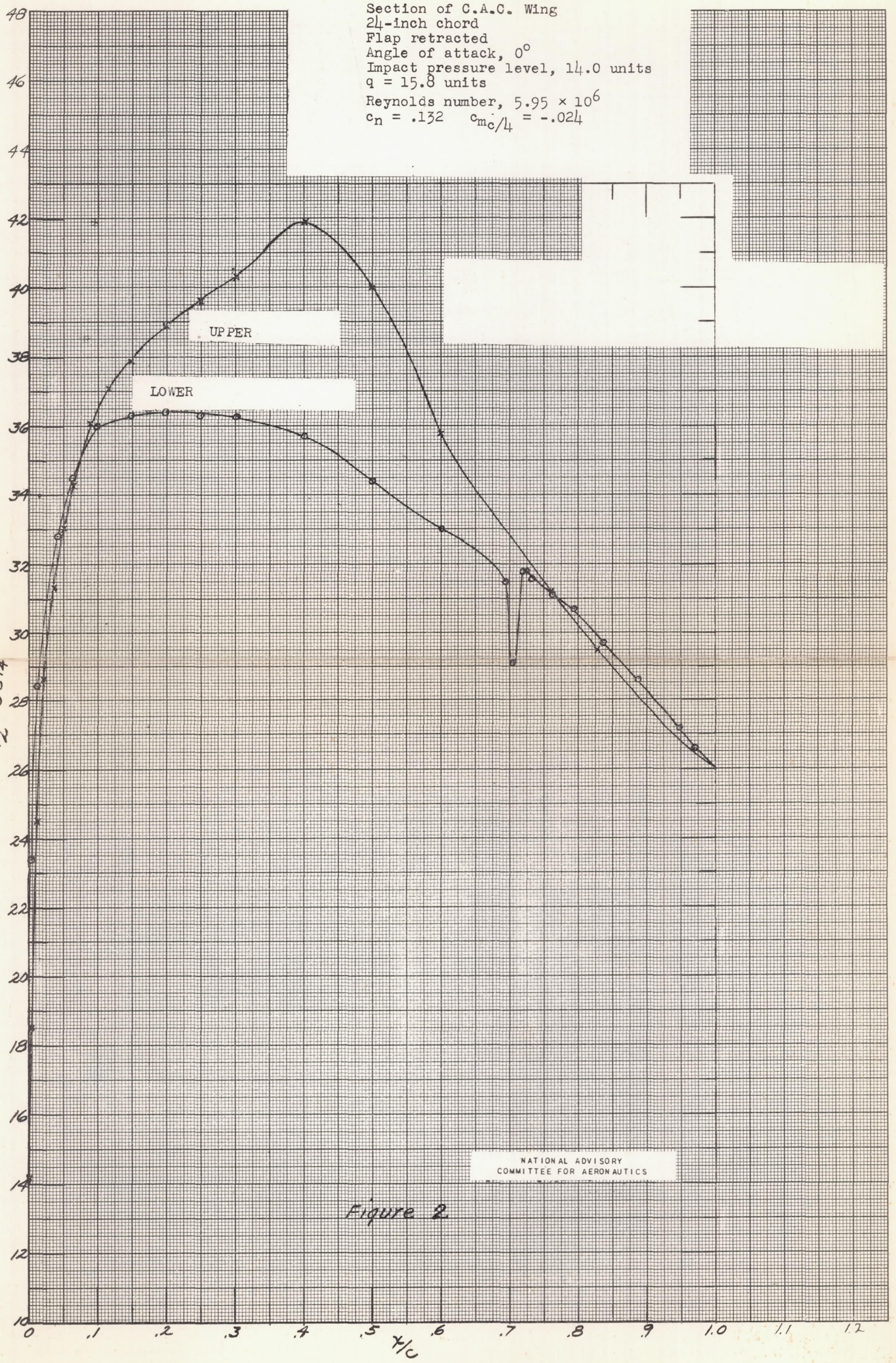

Figure 2

Section of C.A.C. Wing
24-inch chord
Flap retracted
Angle of attack, 2.0°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = .349$ $c_{m_{c/4}} = -.024$

UPPER

LOWER

$\frac{1}{2}$" CC14

48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10

0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1 1.2

x/c

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Figure 3

Section of C.A.C. Wing
24-inch chord
Flap retracted
Angle of attack, 4.1°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = .571$ $c_{m_{c/4}} = -.027$

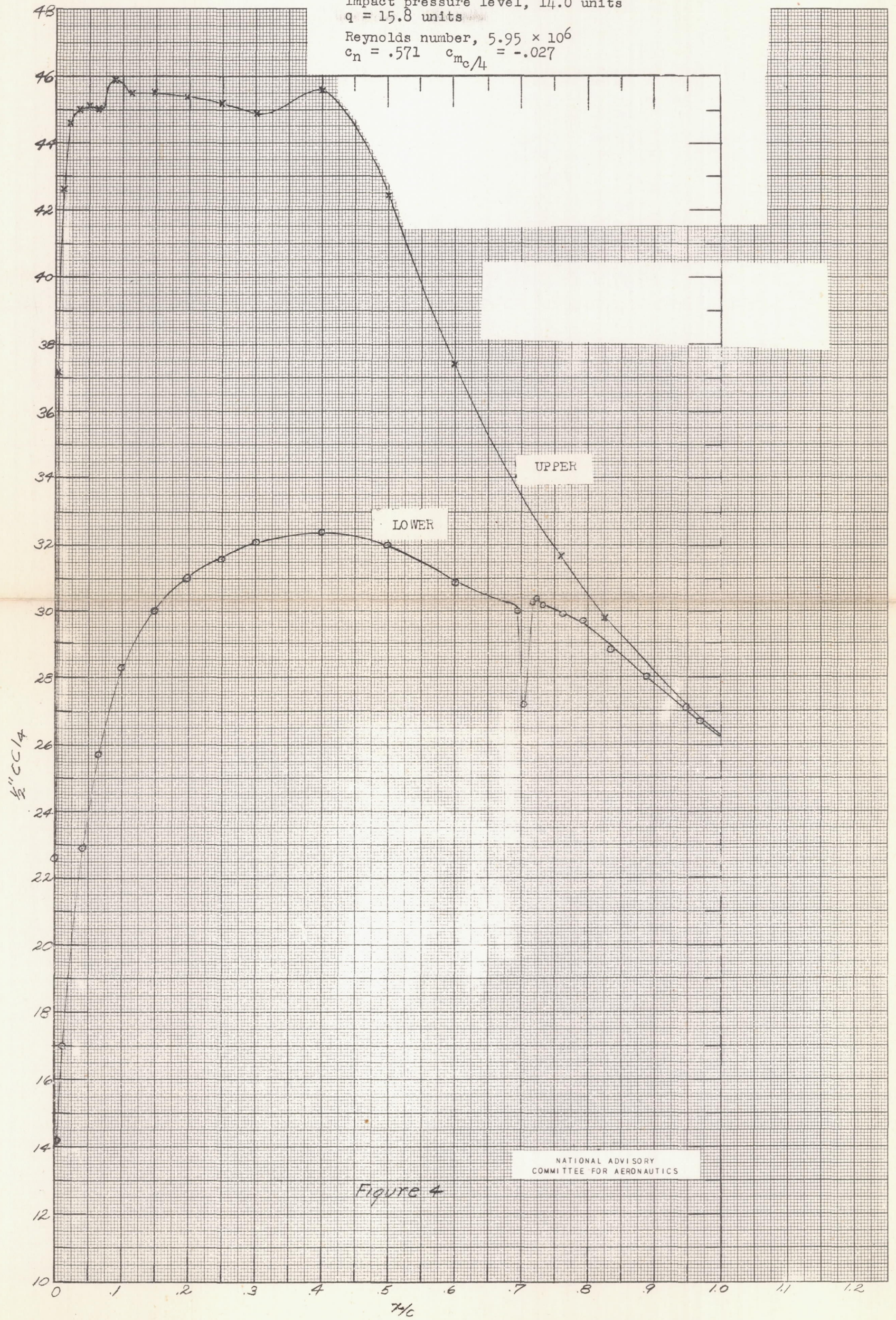

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Figure 4

Section of C.A.C. Wing
24-inch chord
Flap retracted
Angle of attack, 8.1°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = .920$ $c_{m_{c/4}} = -.020$

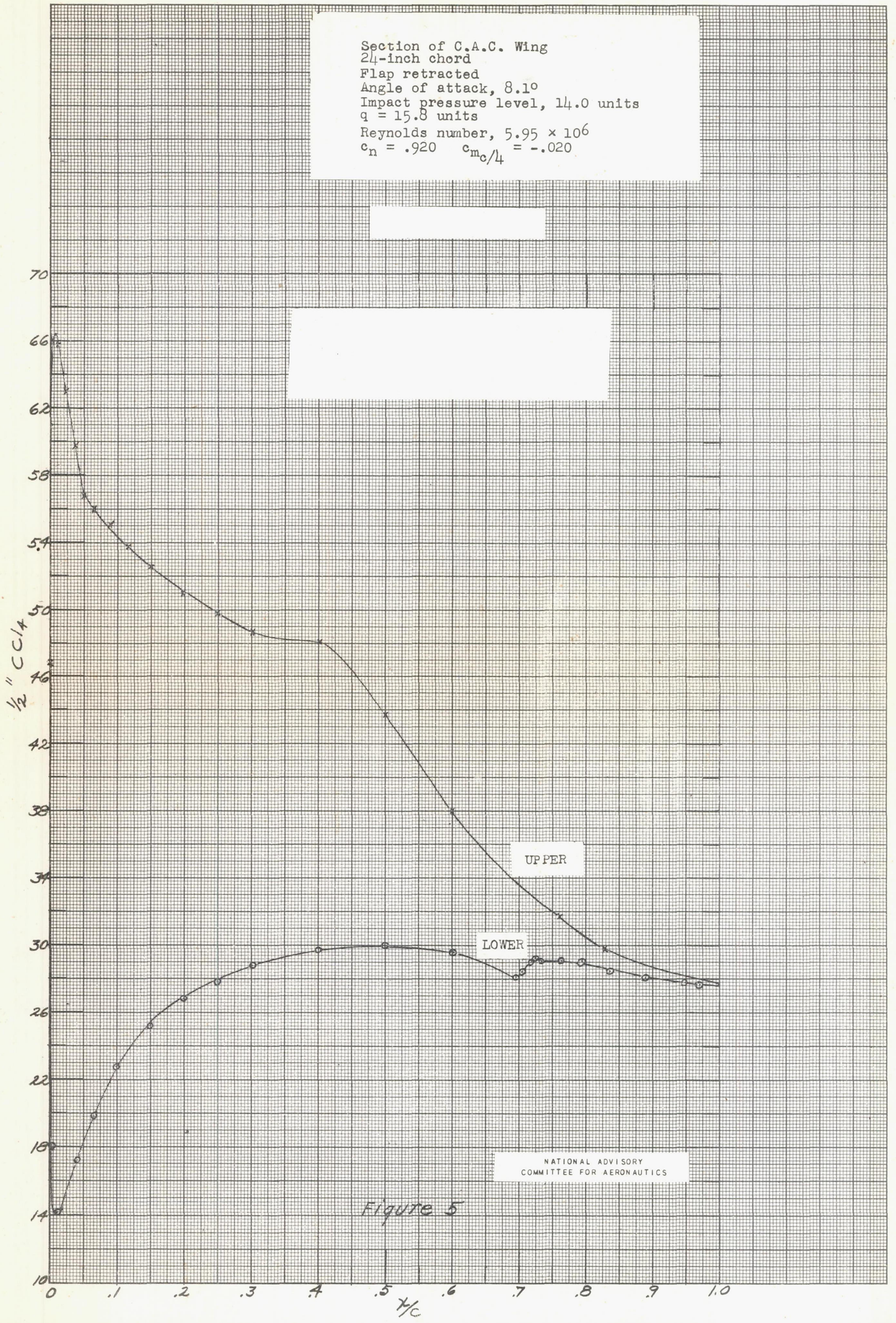

Figure 5

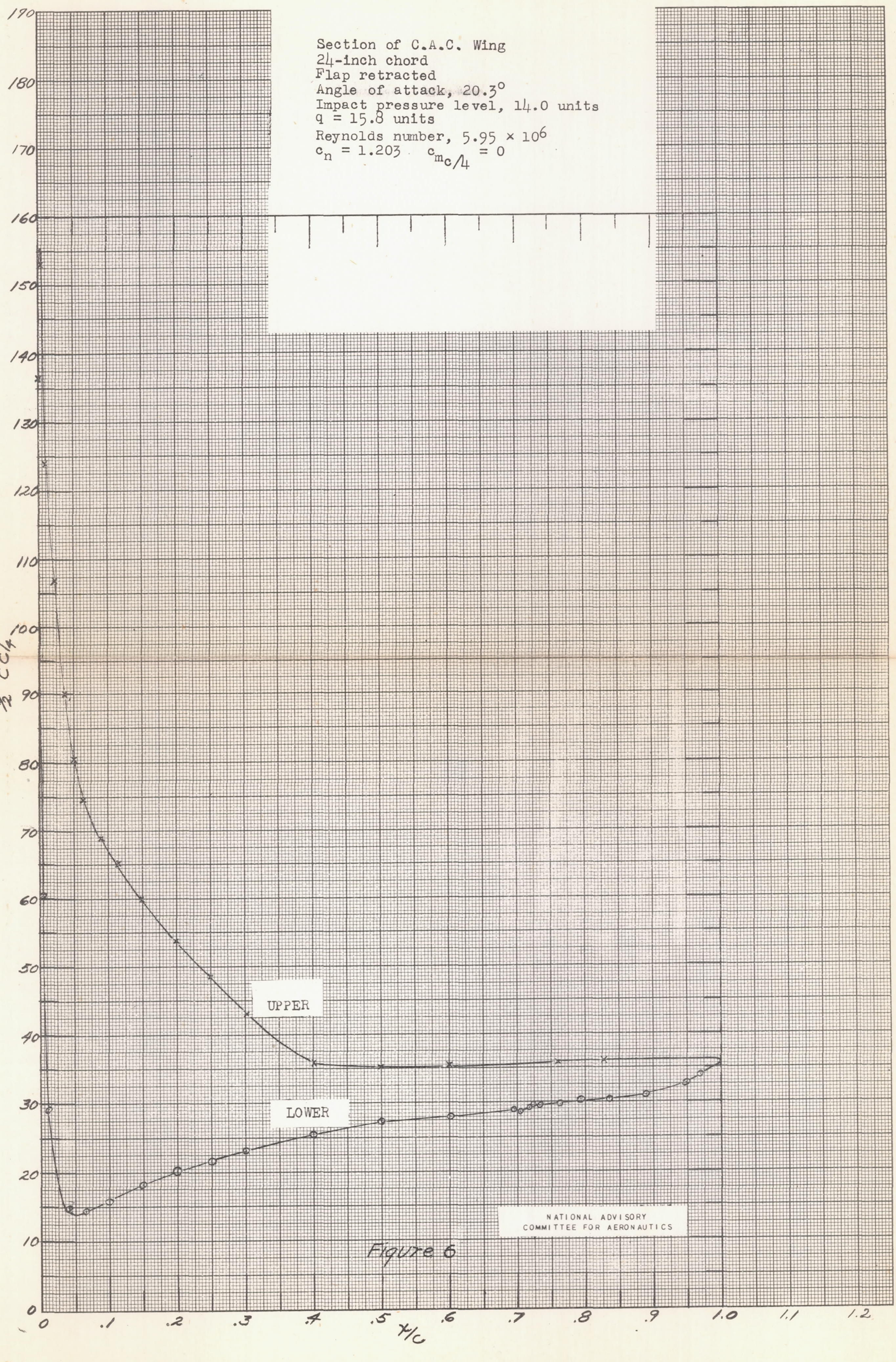
Section of C.A.C. Wing
24-inch chord
Flap retracted
Angle of attack, 20.3°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95 × 10^6
c_n = 1.203 $c_{m_{c/4}}$ = 0
UPPER
LOWER
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
x/c
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

Figure 6

Section of C.A.C. Wing
24-inch chord
Flap deflected 20°
Angle of attack, -8.1°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = -.139$ $c_{m_{c/4}} = -.168$

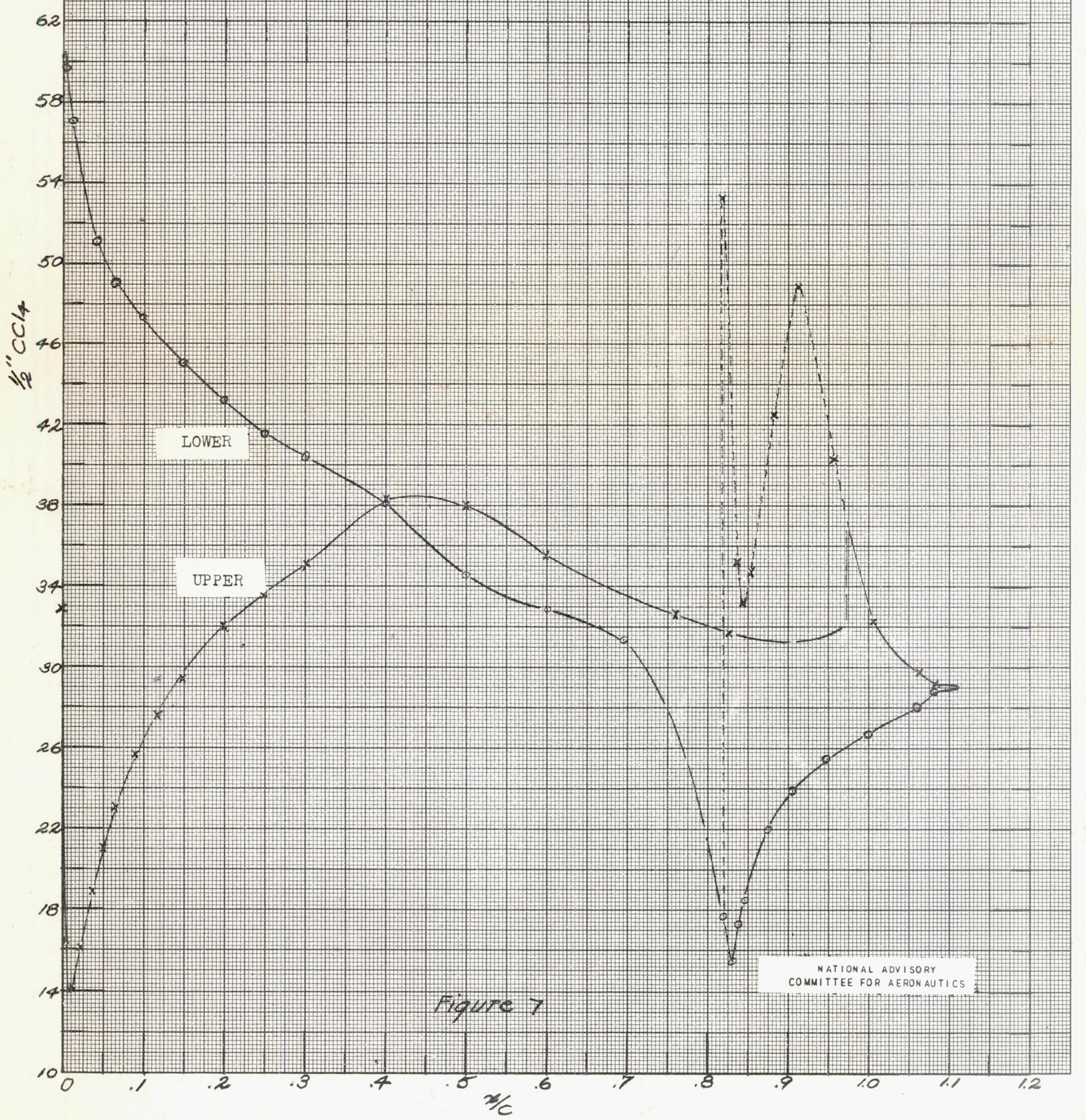

Figure 7

Section of C.A.C. Wing
24-inch chord
Flap deflected 20°
Angle of attack, 0°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = .916$ $c_{m_{c/4}} = -.210$

UPPER

LOWER

$\frac{1}{q}\frac{dp}{dx}$

x/c

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Figure 8

Section of C.A.C. Wing
24-inch chord
Flap deflected 20°
Angle of attack, 4.1°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = 1.407$ $c_{m_{c/4}} = -.227$

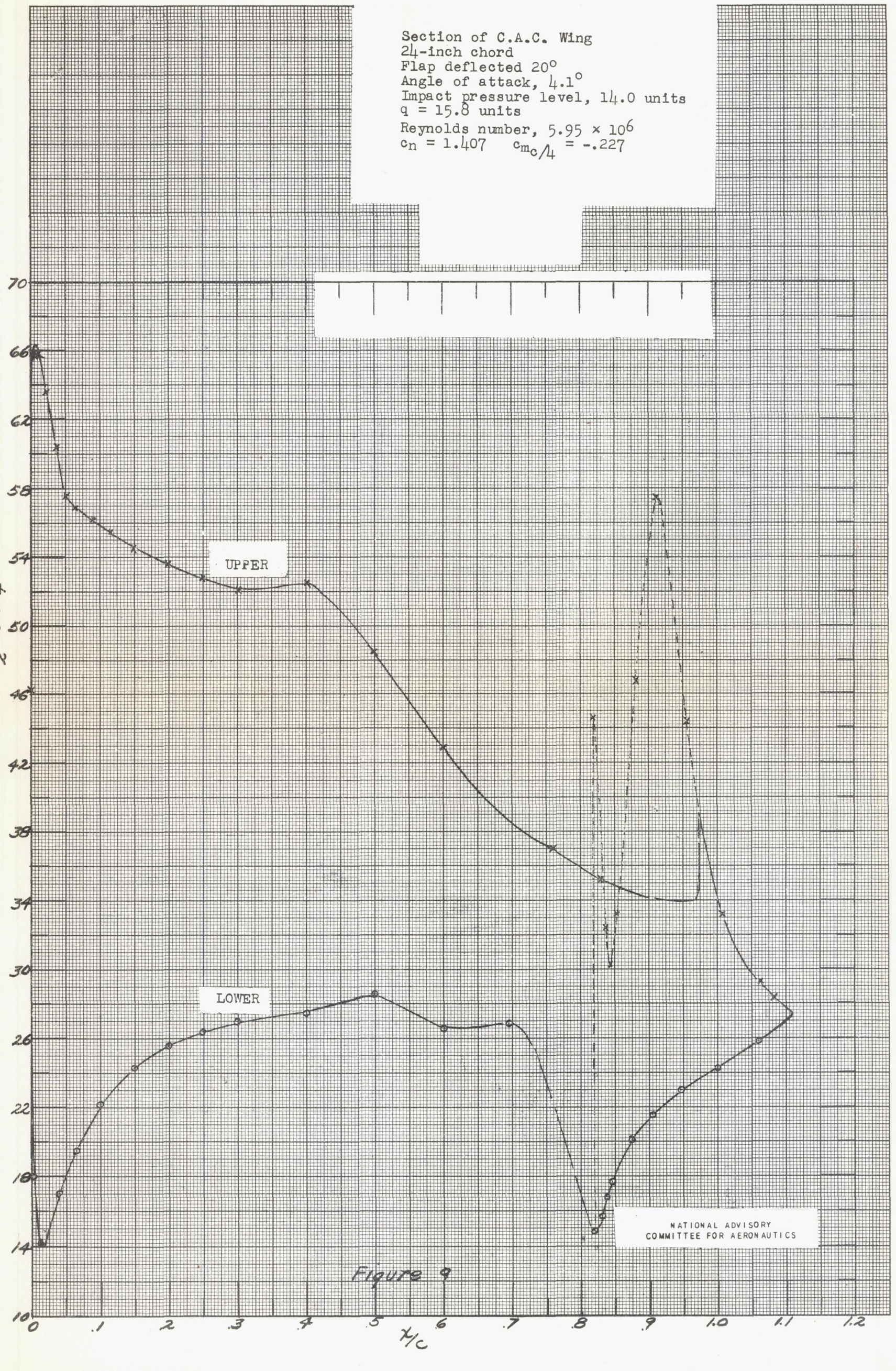

Figure 9

Section of C.A.C. Wing
24-inch chord
Flap deflected 20°
Angle of attack, 8.1°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = 1.840$ $c_{m_{c/4}} = -.239$

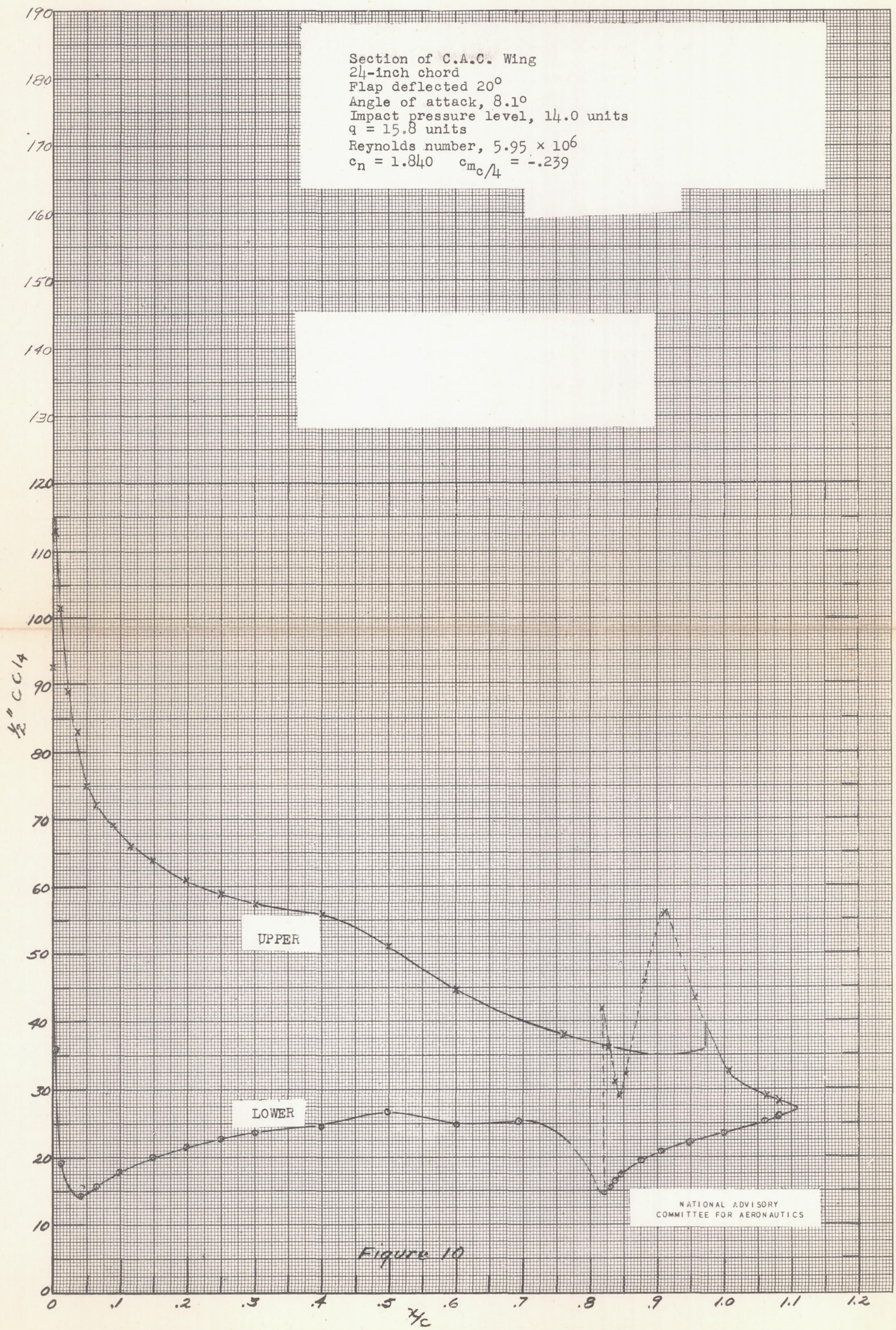

Figure 10

Section of C.A.C. Wing
24-inch chord
Flap deflected 20°
Angle of attack, 12.7°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = 2.188$ $c_{m_{c/4}} = -.236$

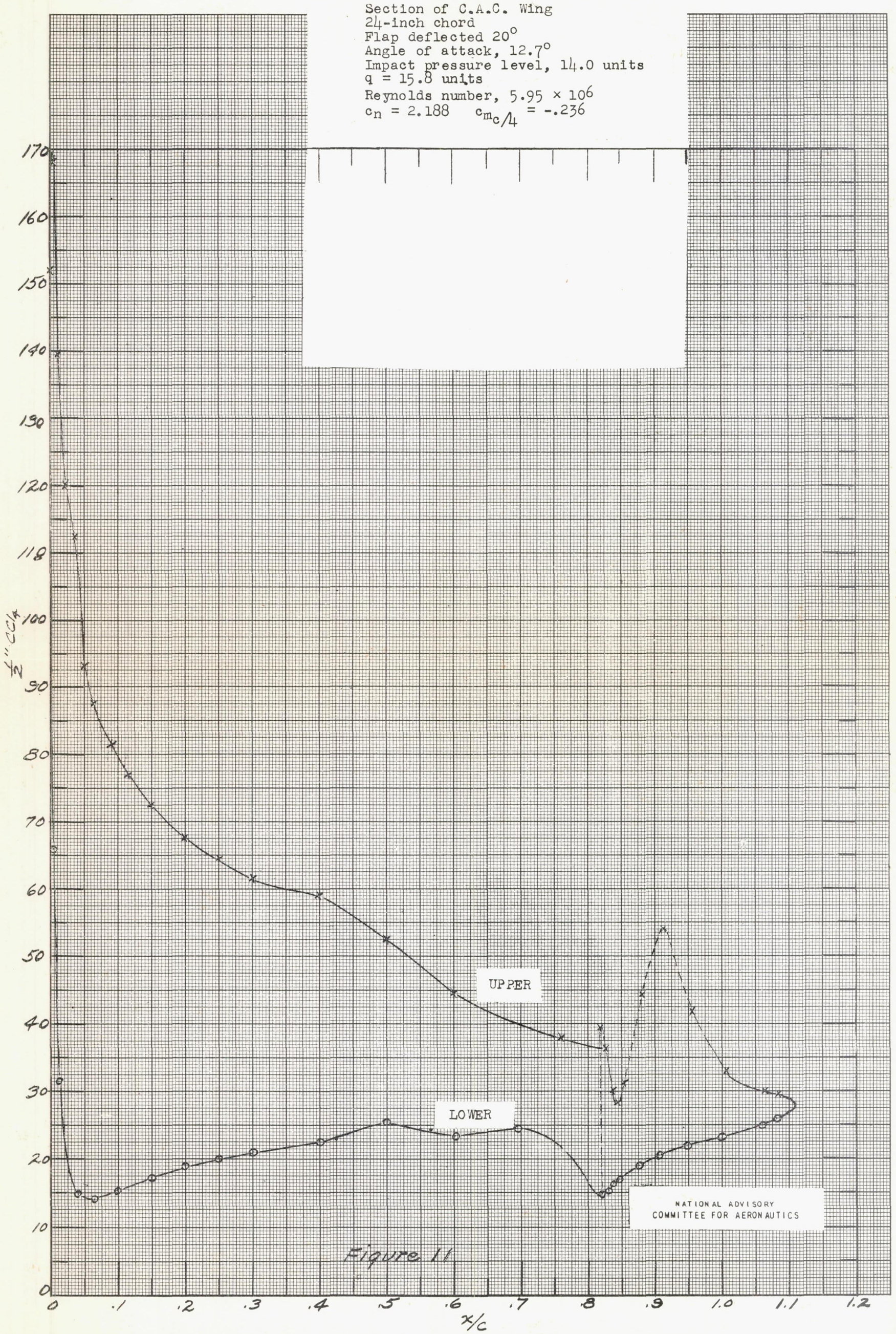

Figure 11

Section of C.A.C. Wing
24-inch chord
Flap deflected 40°
Angle of attack, -16.2°
Impact pressure level, 14.0 units
q = 15.8 units

Reynolds number, 5.95×10^6
$c_n = -.097$ $c_{m_{c/4}} = -.376$

LOWER

UPPER

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Figure 12

$\frac{1}{2}$ "CCW

x/c

Section of C.A.C. Wing
24-inch chord
Flap deflected 40°
Angle of attack, -8.1°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = 1.017$ $c_{m_{c/4}} = -.478$

78
74
70
66
62
58
54
50
46
42
38
34
30
26
22
18
14
10

"CC/4

UPPER

LOWER

0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1 1.2

x/c

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Figure 13

Section of C.A.C. Wing
24-inch chord
Flap deflected 40°
Angle of attack, 0°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = 2.022$ $c_{m_{c/4}} = -.519$

UPPER

LOWER

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Figure 14

$\frac{1}{2}$ "CC/4

86 82 78 74 70 66 62 58 54 50 46 42 38 34 30 26 22 18 14 10

0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1 1.2

x/c

L-700

Section of C.A.C. Wing
24-inch chord
Flap deflected 40°
Angle of attack, 8.1°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number, 5.95×10^6
$c_n = 2.876$ $c_{m_{c/4}} = -.519$

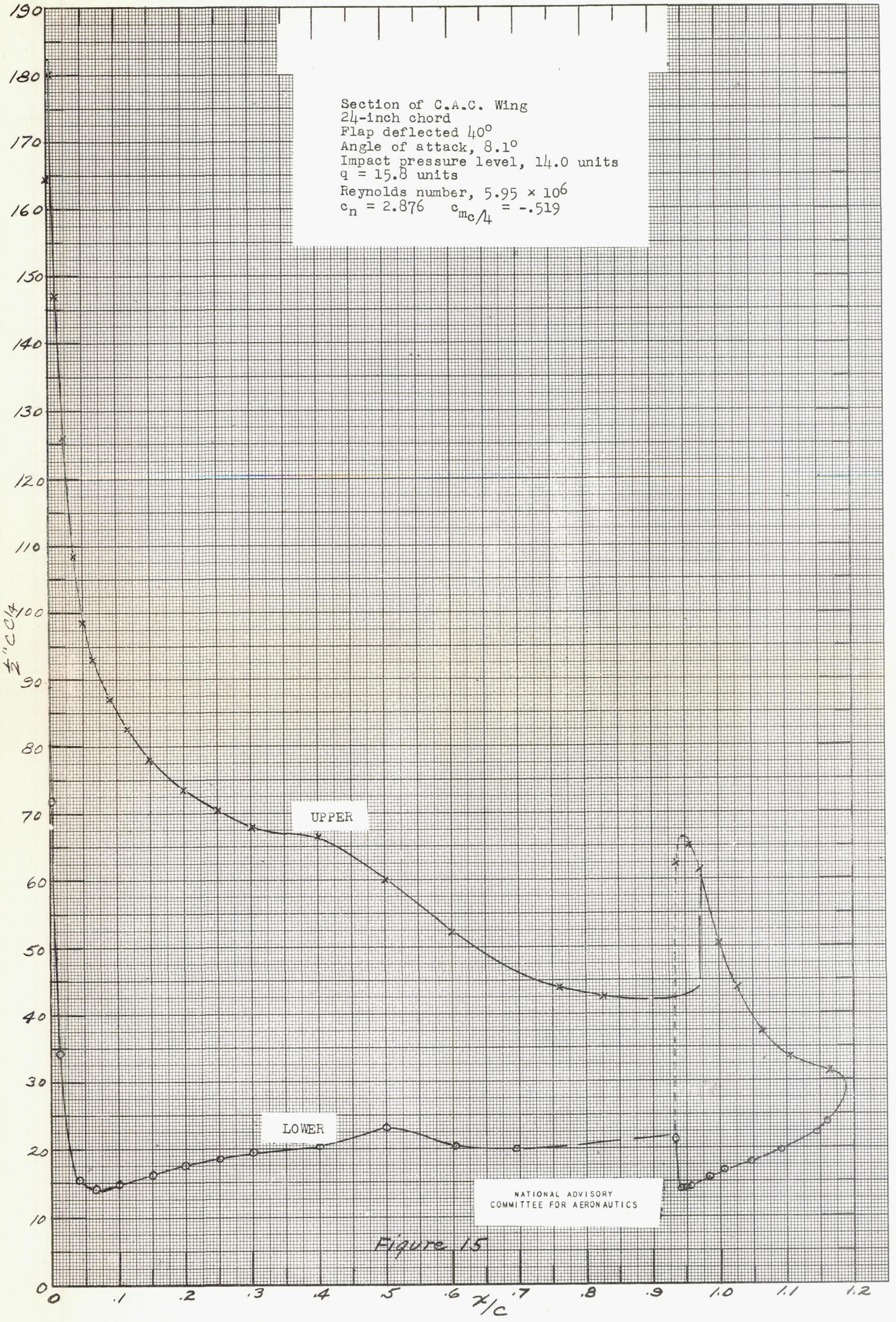

Figure 15

Section of C.A.C. Wing
24-inch chord
Flap deflection, 40°
Angle of attack, 11.7°
Impact pressure level, 14.0 units
q = 15.8 units
Reynolds number = 5.95×10^6
$c_n = 3.103$ $c_{m_{c/4}} = -.497$

380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0

½" CC14

0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1 1.2

x/c

UPPER

LOWER

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Figure 16

L-700

Section of Low-Drag Wing
24-inch chord
Flap retracted
Angle of attack, -2.0°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = .024 $c_{m_{c/4}}$ = -.051

UPPER

LOWER

48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16

1/2 = cc/4

0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

x/c

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Figure 17

Section of Low-Drag Wing
24-inch chord
Flap retracted
Angle of attack, 0°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = .257 $c_{m_{c/4}}$ = -.066

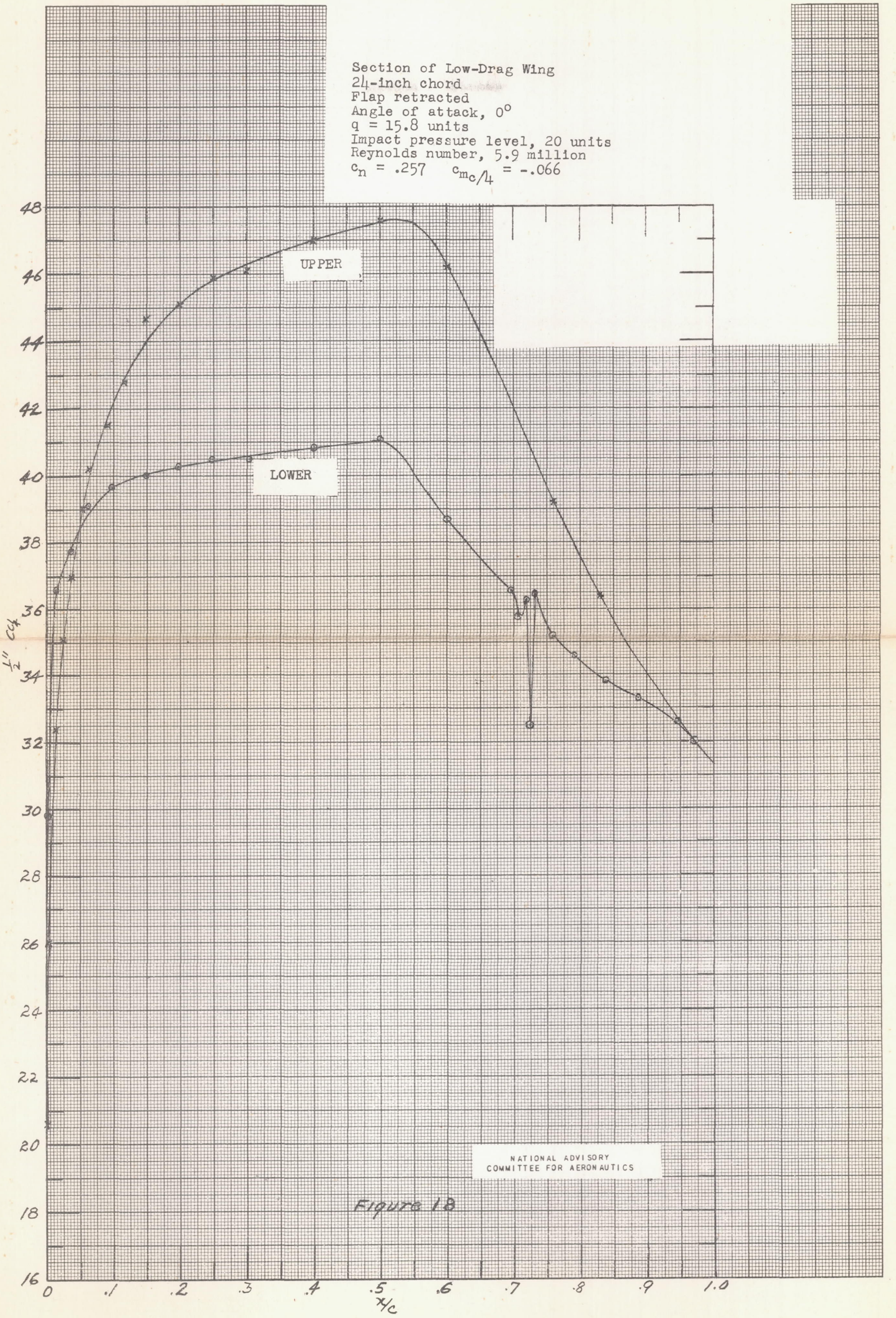

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Figure 18

Section of Low-Drag Wing
24-inch chord
Flap retracted
Angle of attack, 2.0°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = .472 $c_{m_{c/4}}$ = -.064

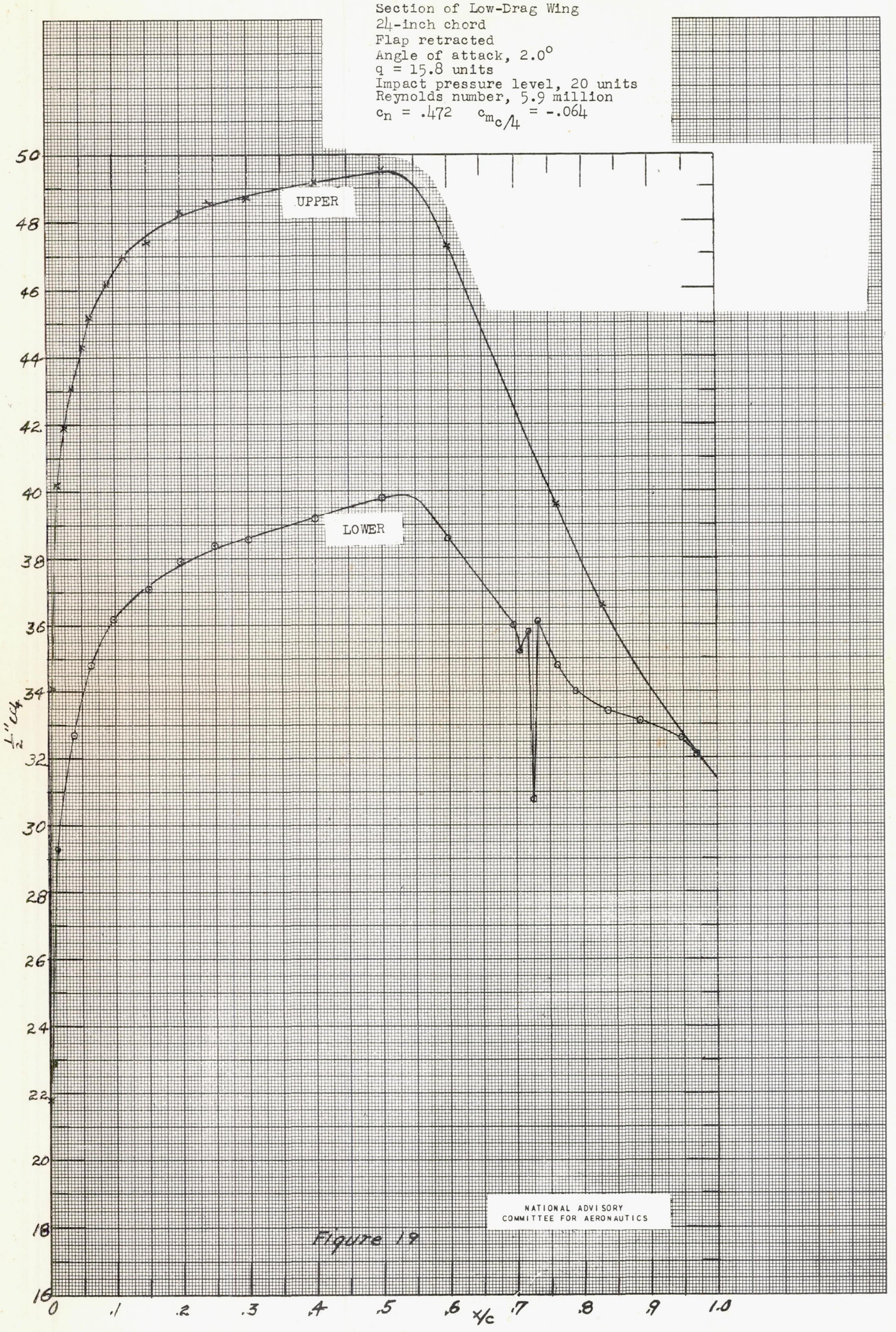

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Figure 19

Section of Low-Drag Wing
24-inch chord
Flap retracted
Angle of attack, 4.1°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = .682 $c_{m_{c/4}}$ = -.068

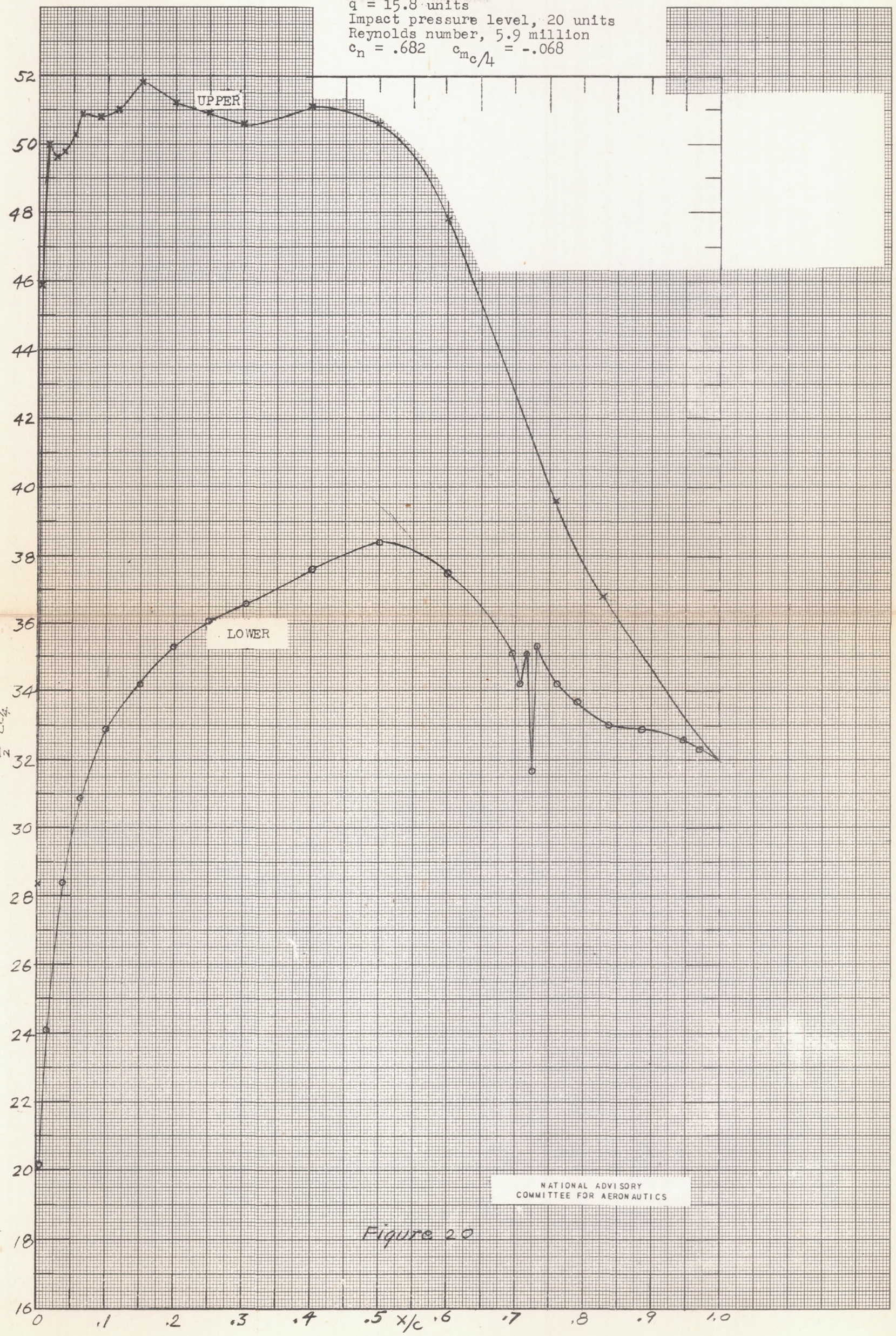

Figure 20

Section of Low-Drag Wing
24-inch chord
Flap retracted
Angle of attack, 6.1°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9×10^6
$c_n = .810$ $c_{m_{c/4}} = -.053$

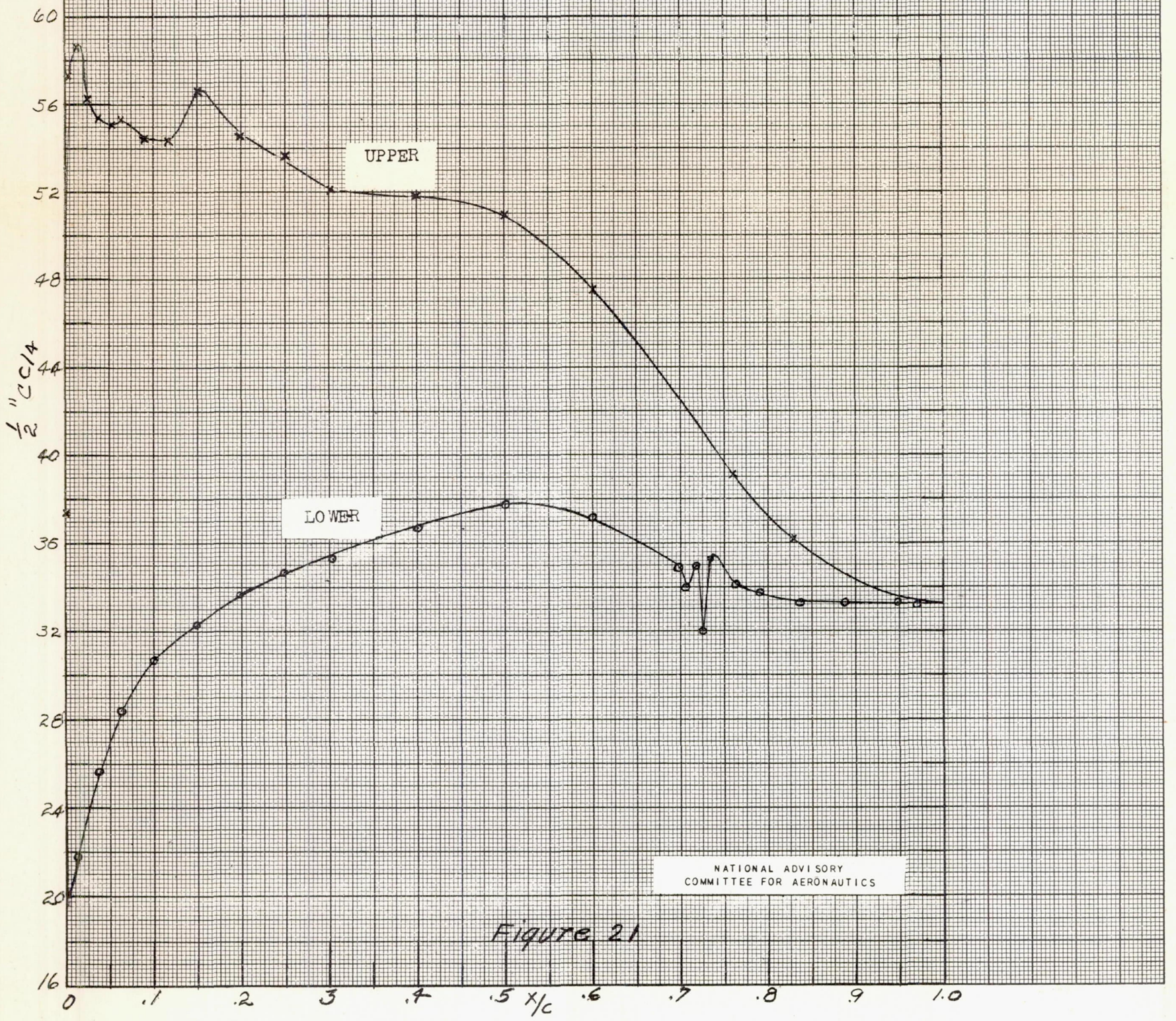

Figure 21

Section of Low-Drag Wing
24-inch chord
Flap retracted
Angle of attack, 12.2°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
$c_n = 1.124$ $c_{m_{c/4}} = -.024$

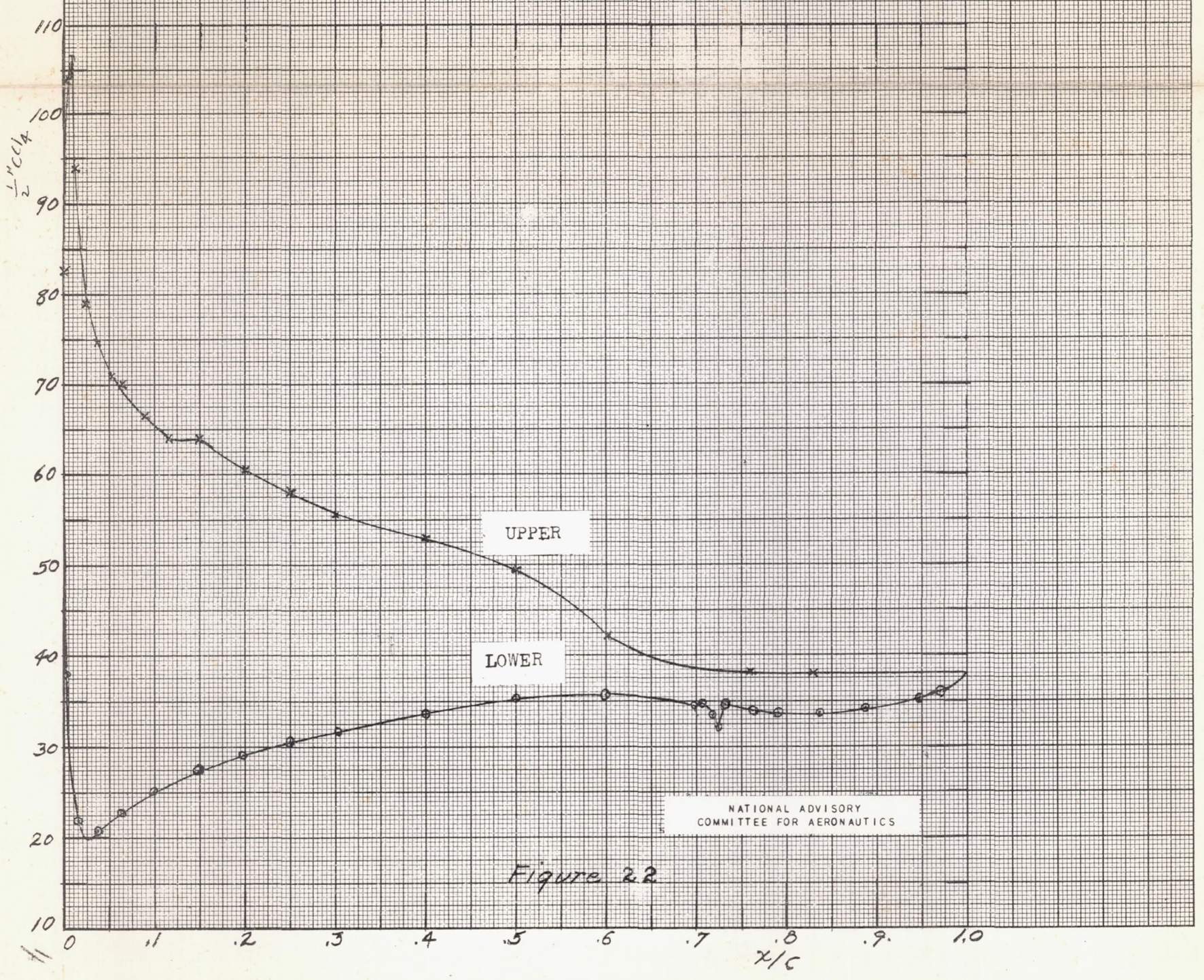

Figure 22

Section of Low-Drag Wing
24-inch chord
Flap retracted
Angle of attack, 20.3°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = 1.328 $c_{m_{c/4}}$ = -.011

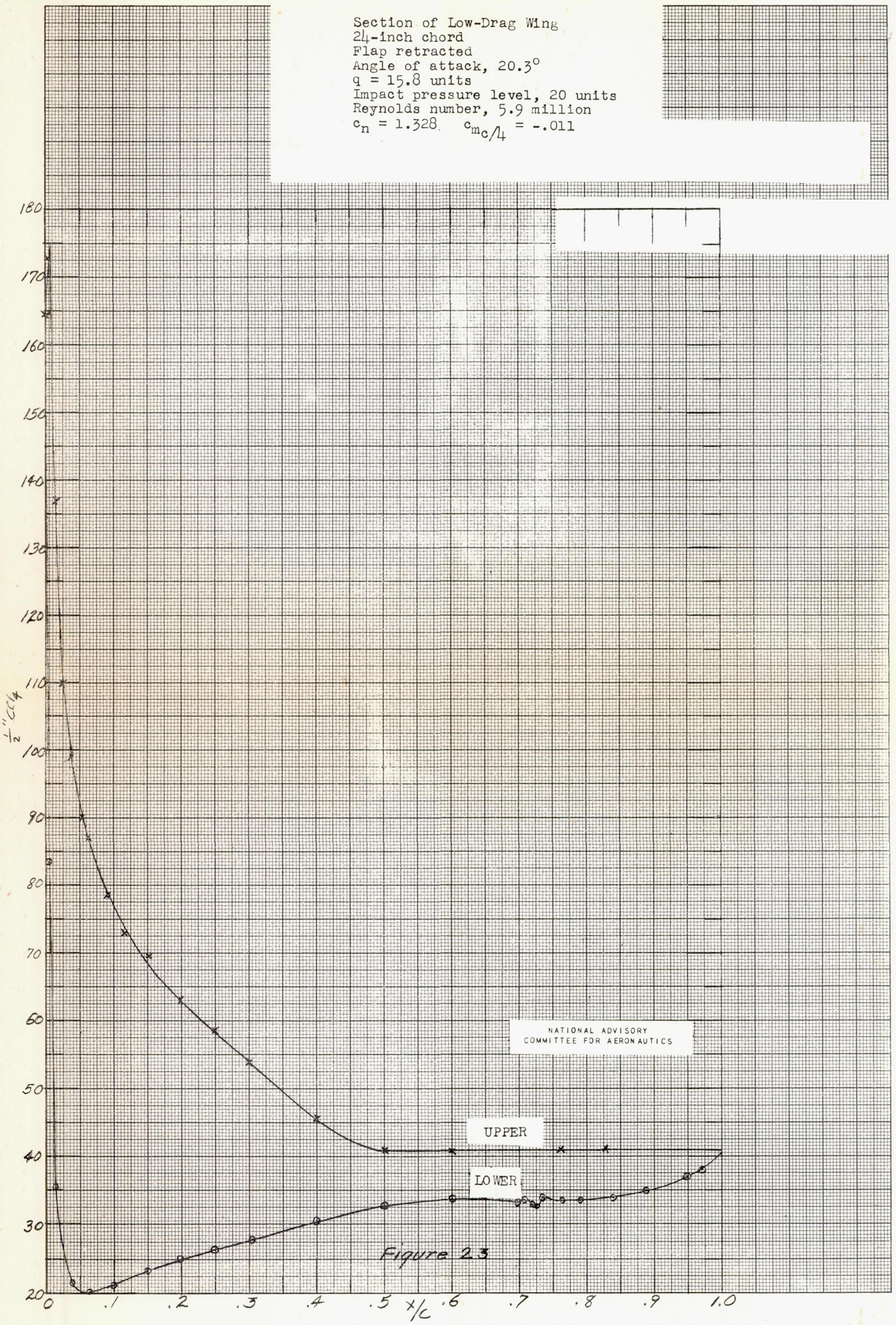

Figure 23

Section of Low-Drag Wing
24-inch chord
Flap deflected 20°
Angle of attack, -8.1°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = .138 $c_{m_{c/4}}$ = -.236

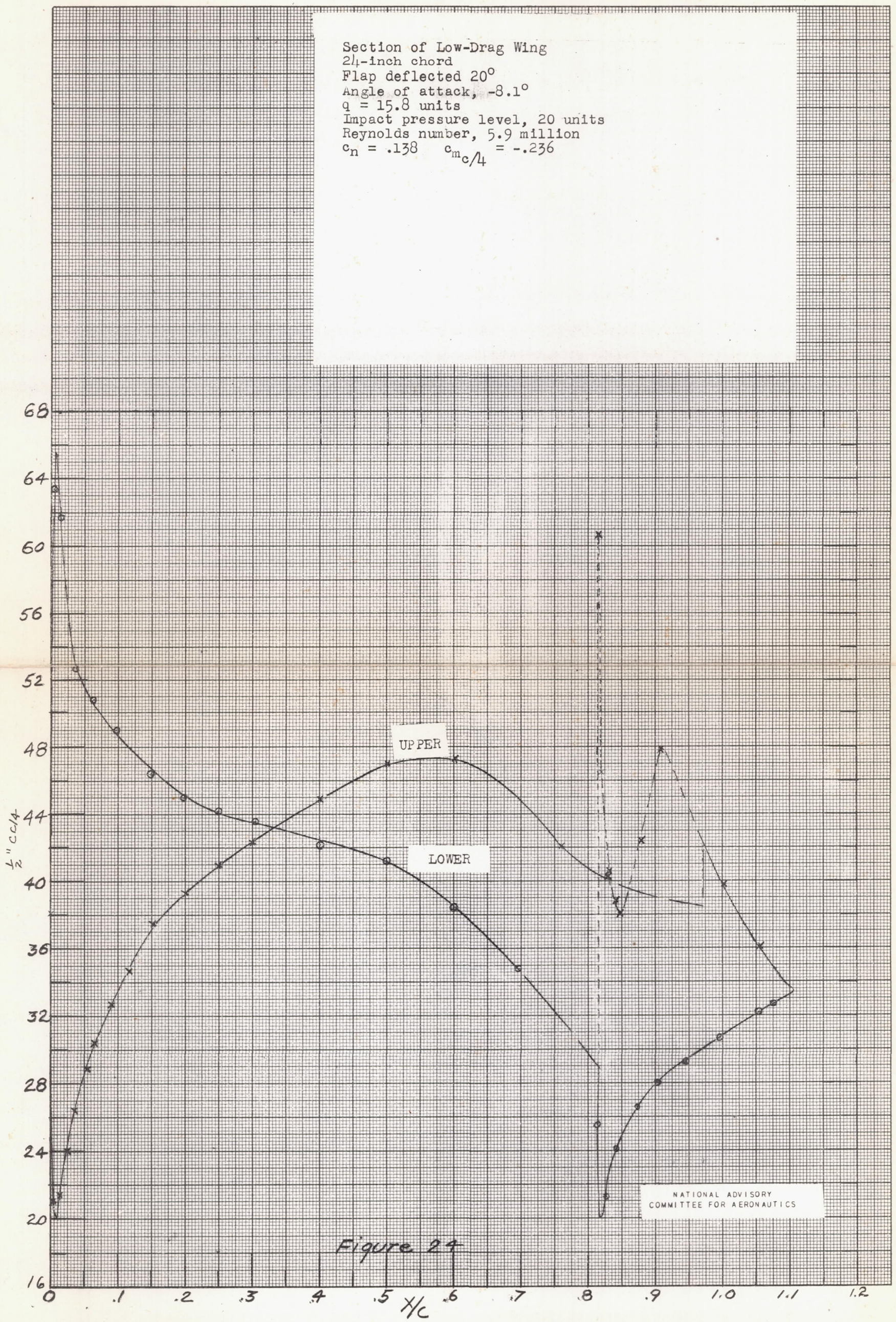

Figure 24

Section of Low-Drag Wing
24-inch chord
Flap deflected 20°
Angle of attack, 0°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = 1.175 $c_{m_{c/4}}$ = -.271

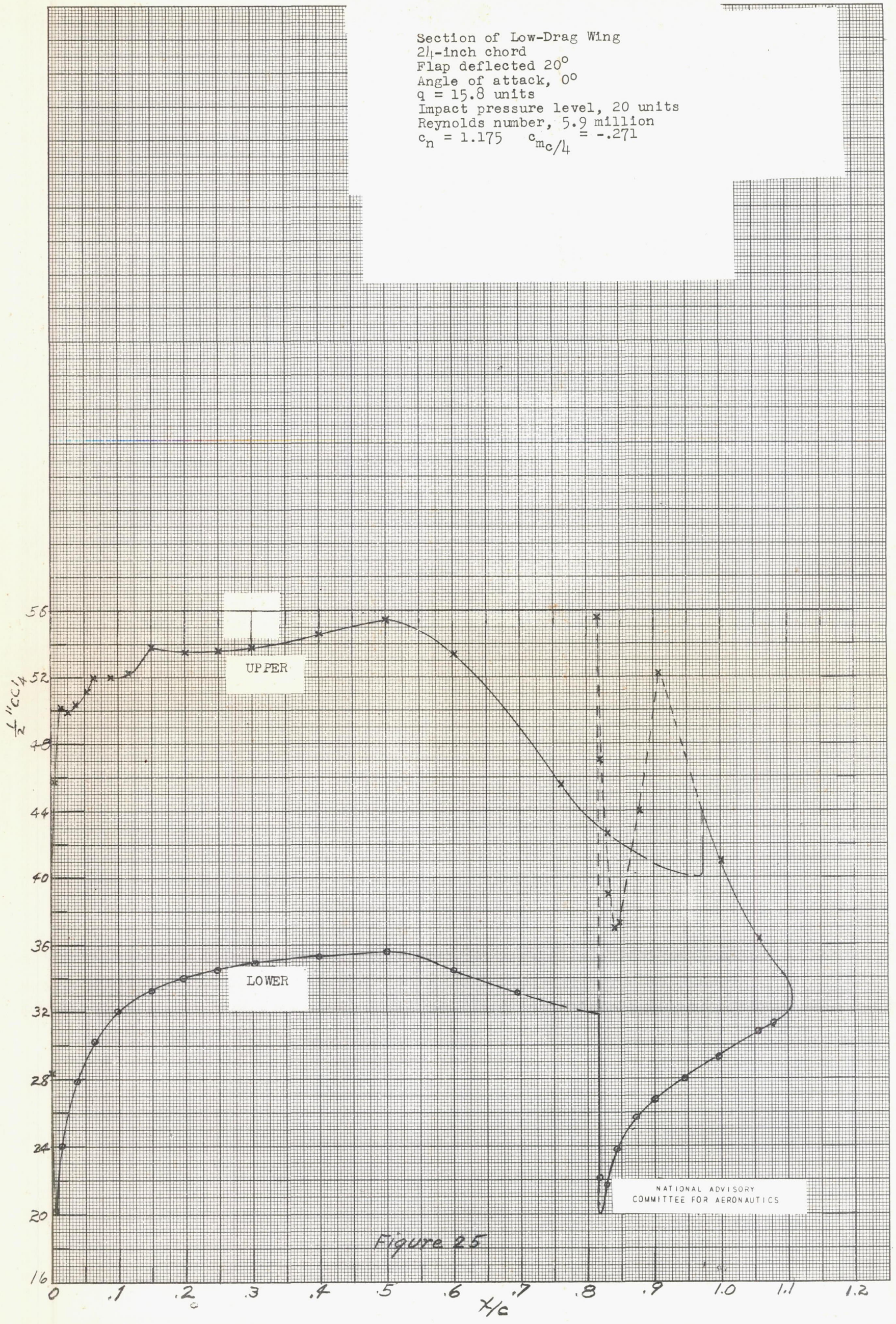

Figure 25

Section of Low-Drag Wing
24-inch chord
Flap deflected 20°
Angle of attack, 4.1°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = 1.631 $c_{m_{c/4}}$ = -.278

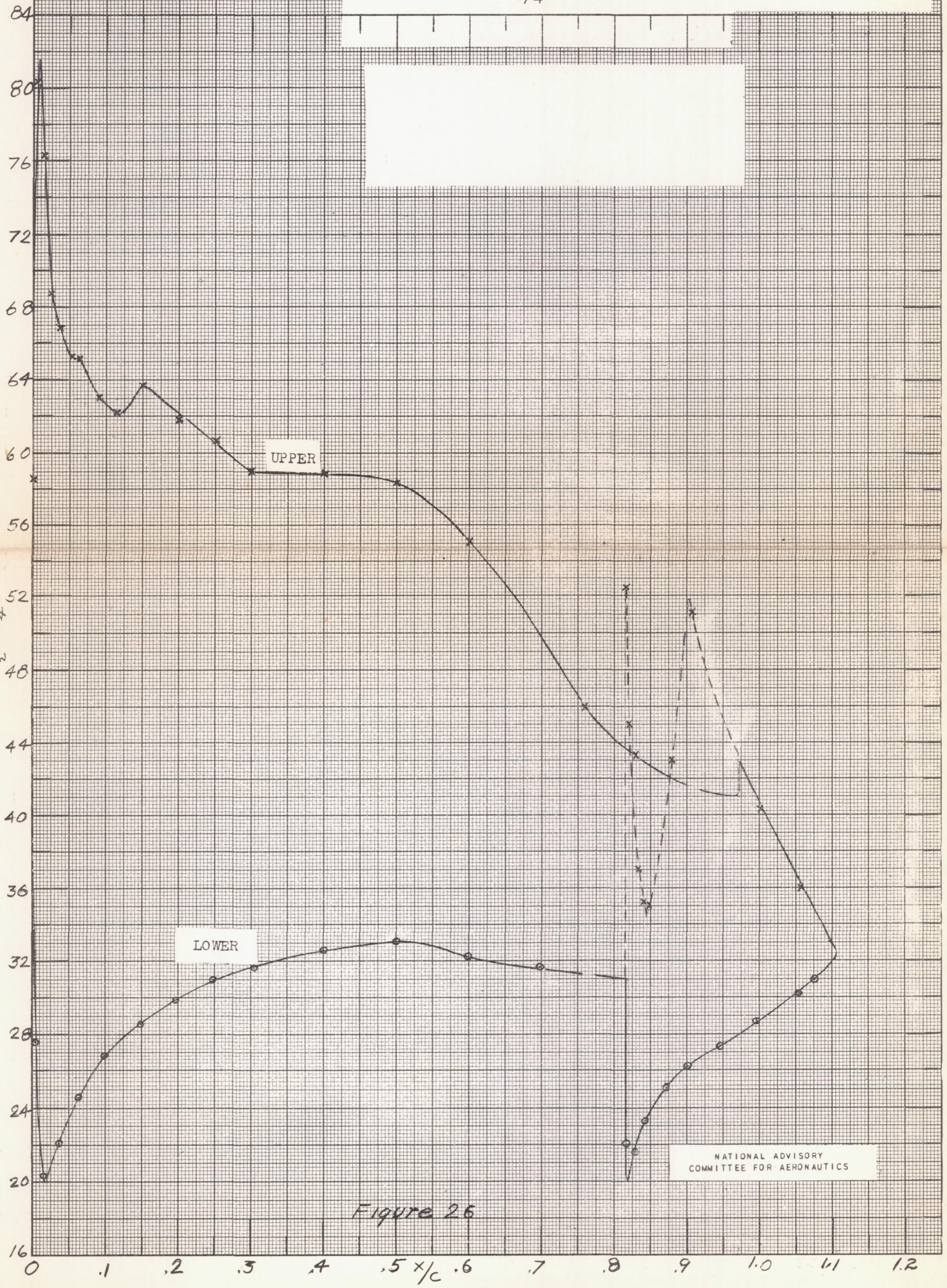

Figure 26

Section of Low-Drag Wing
24-inch chord
Flap deflected 20°
Angle of attack, 8.1°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = 2.008 $c_{m_{c/4}}$ = -.278

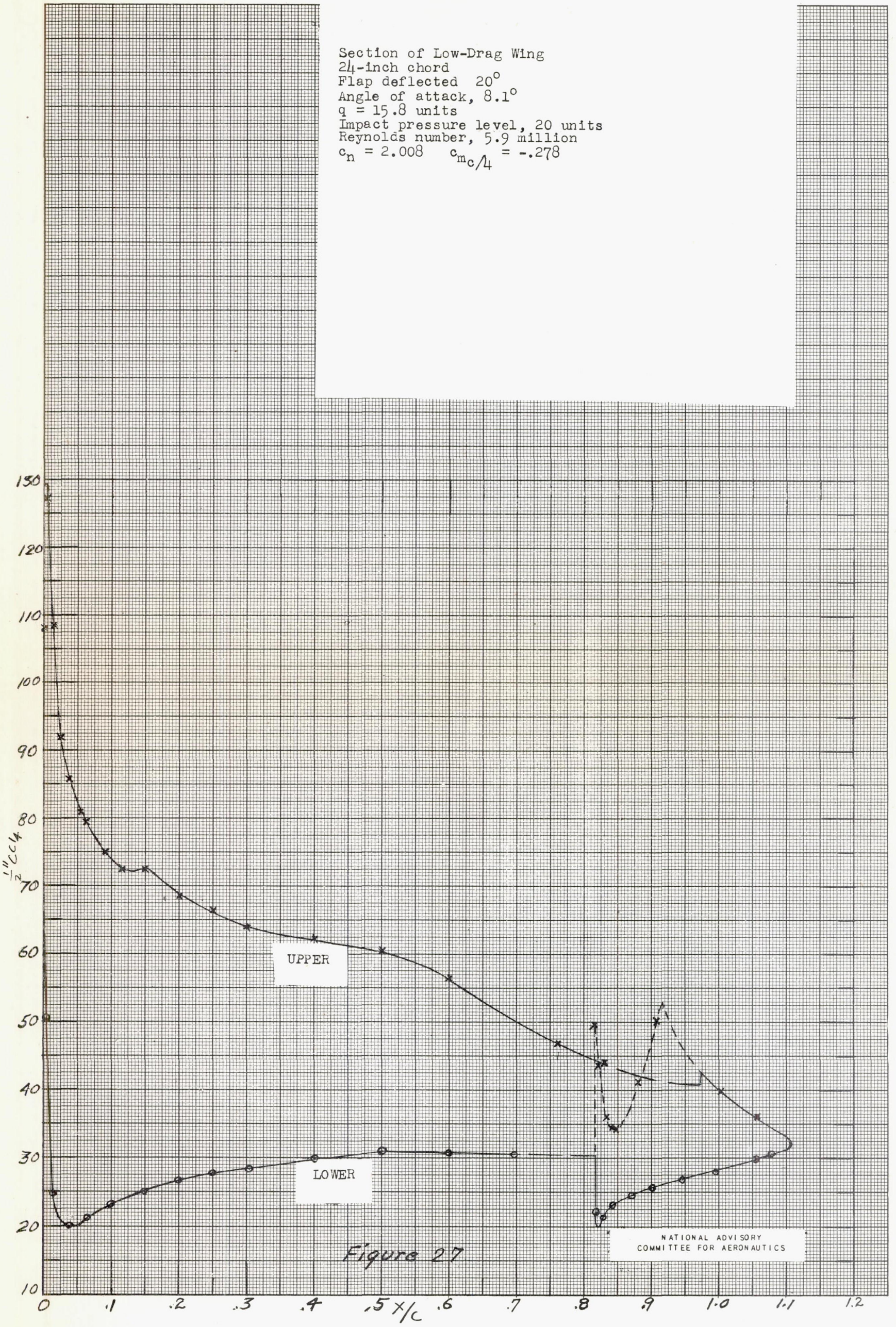

Figure 27

Section of Low-Drag Wing
24-inch chord
Flap deflected 20°
Angle of attack, 10.2°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
$c_n = 2.147$ $c_{m_{c/4}} = -.272$

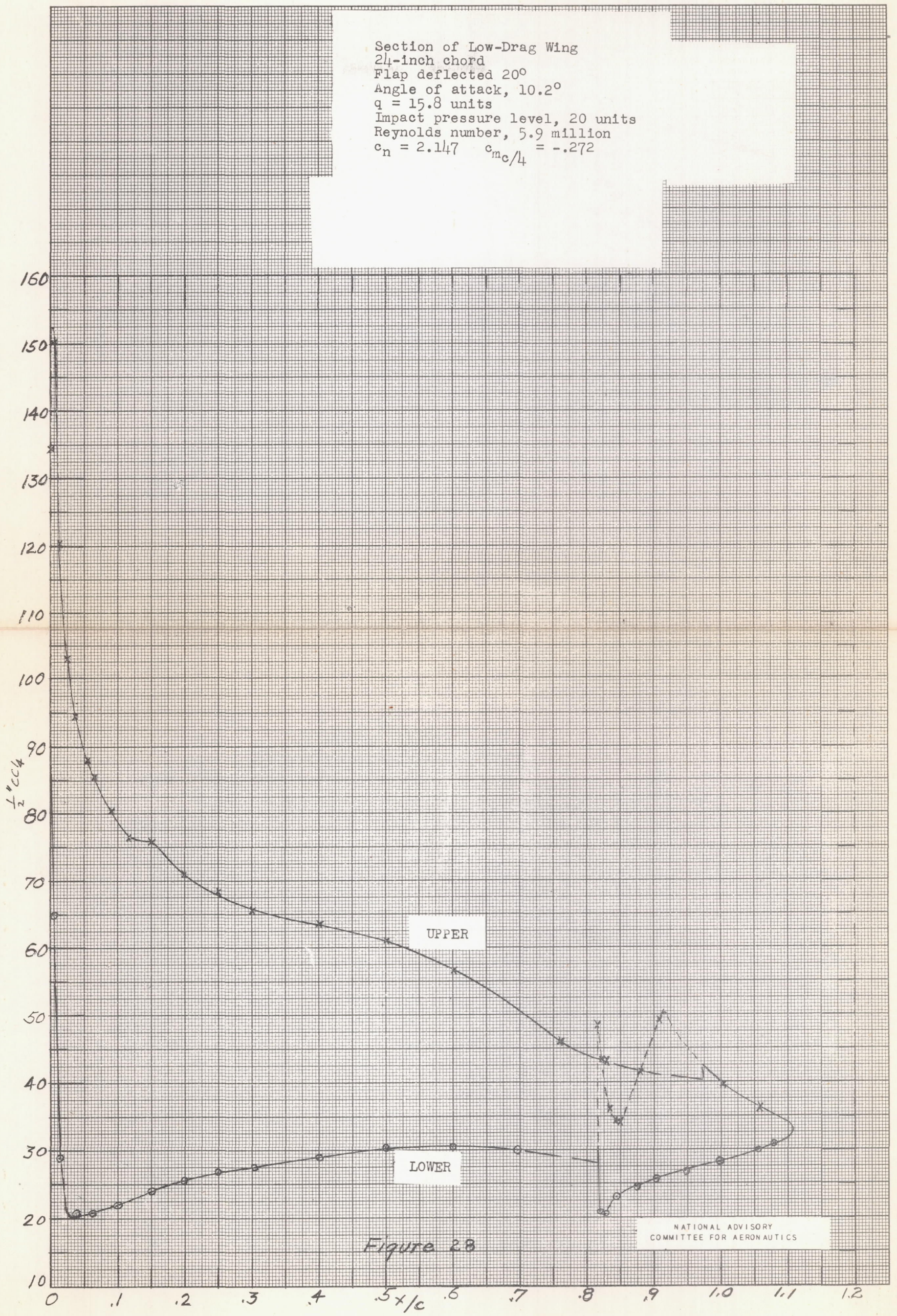

Figure 28

Section of Low-Drag Wing
24-inch chord
Flap deflected 40°
Angle of attack, -17.3°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = .096 $c_{m_{c/4}}$ = -.472

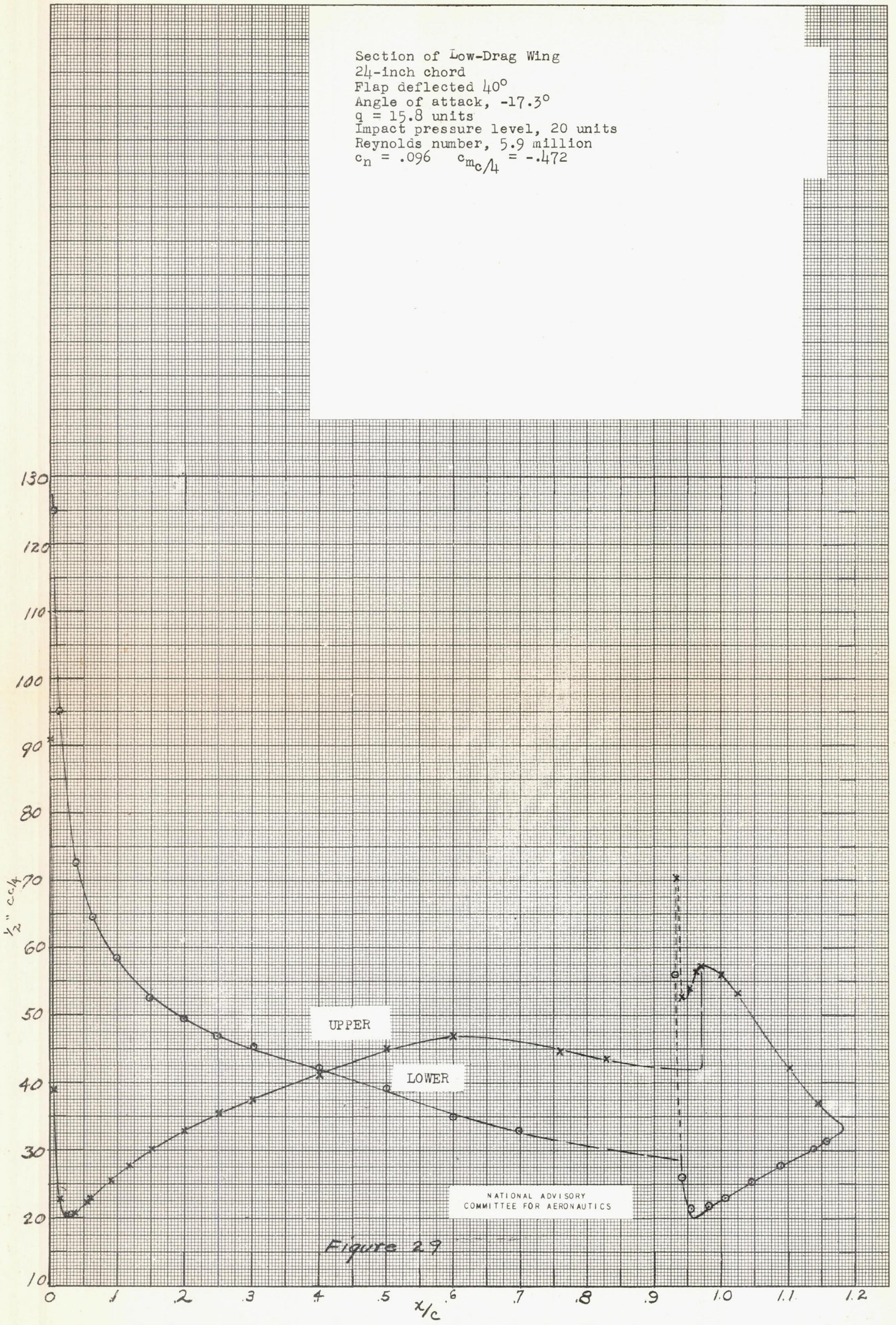

Figure 29

Section of Low-Drag Wing
24-inch chord
Flap deflected 40°
Angle of attack, -8.1°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = 1.468 $c_{m_{c/4}}$ = -.613

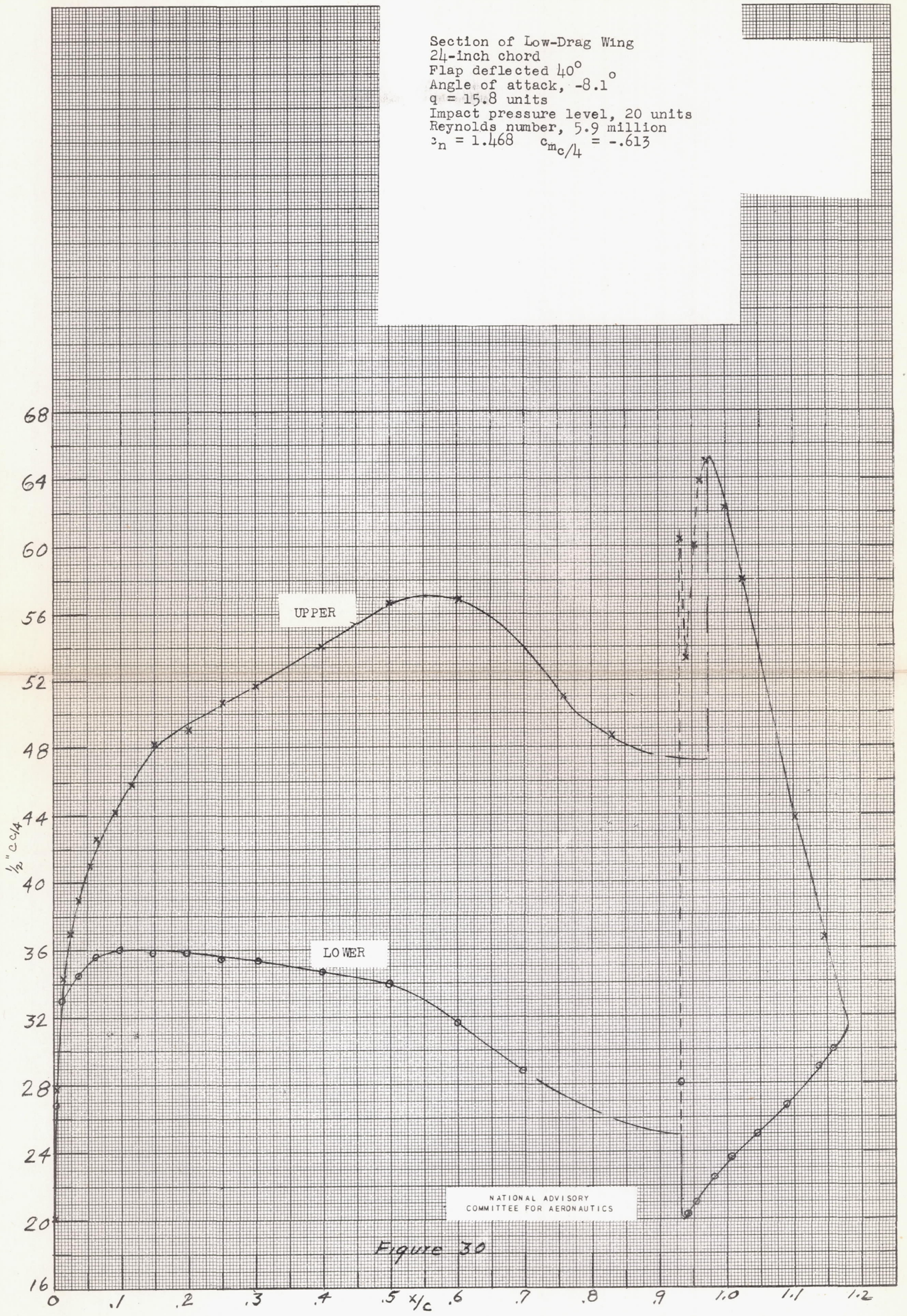

Figure 30

Section of Low-Drag Wing
24-inch chord
Flap deflected 40°
Angle of attack, 0°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = 2.473 $c_{m_{c/4}}$ = -.647

UPPER

LOWER

$\frac{1}{2}$"CCA

92 88 84 80 76 72 68 64 60 56 52 48 44 40 36 32 28 24 20 16

0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1 1.2

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Figure 31

Section of Low-Drag Wing
24-inch chord
Flap deflected 40°
Angle of attack, 9.6°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 5.9 million
c_n = 3.050 $c_{m_{c/4}}$ = -.552

UPPER

LOWER

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$\frac{1}{2}\rho V^2 c$

Figure 32

Section of Low-Drag Wing
24-inch chord
Flap deflected 30°
Angle of attack, -8.1°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 4.3 million
c_n = 1.045 $c_{m_{c/4}}$ = -.551

National Advisory Committee for Aeronautics

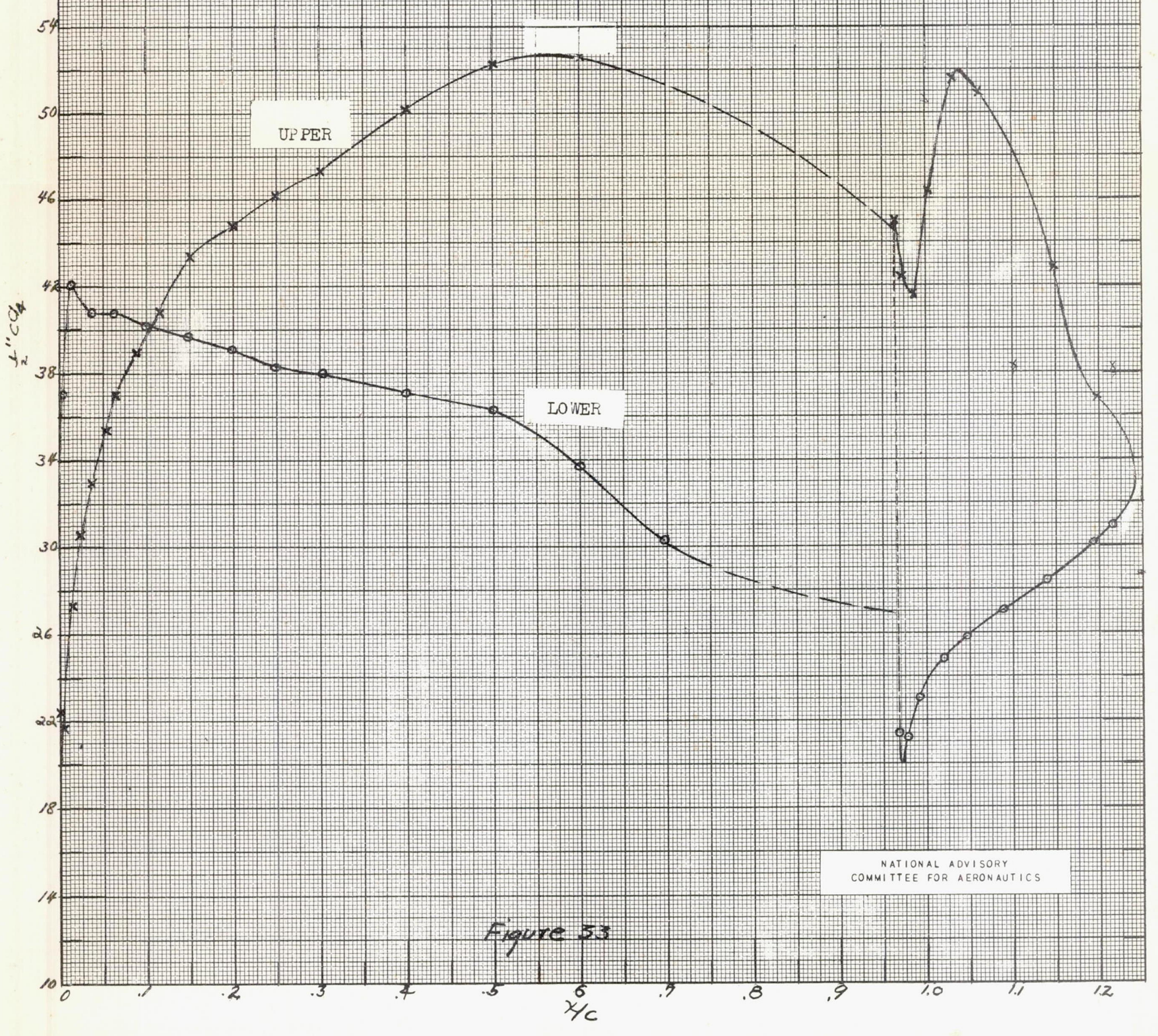

Figure 53

Section of Low-Drag Wing
24-inch chord
Flap deflected 30°
Angle of attack, 0°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 4.3 million
c_n = 2.076 $c_{m_{c/4}}$ = -.584

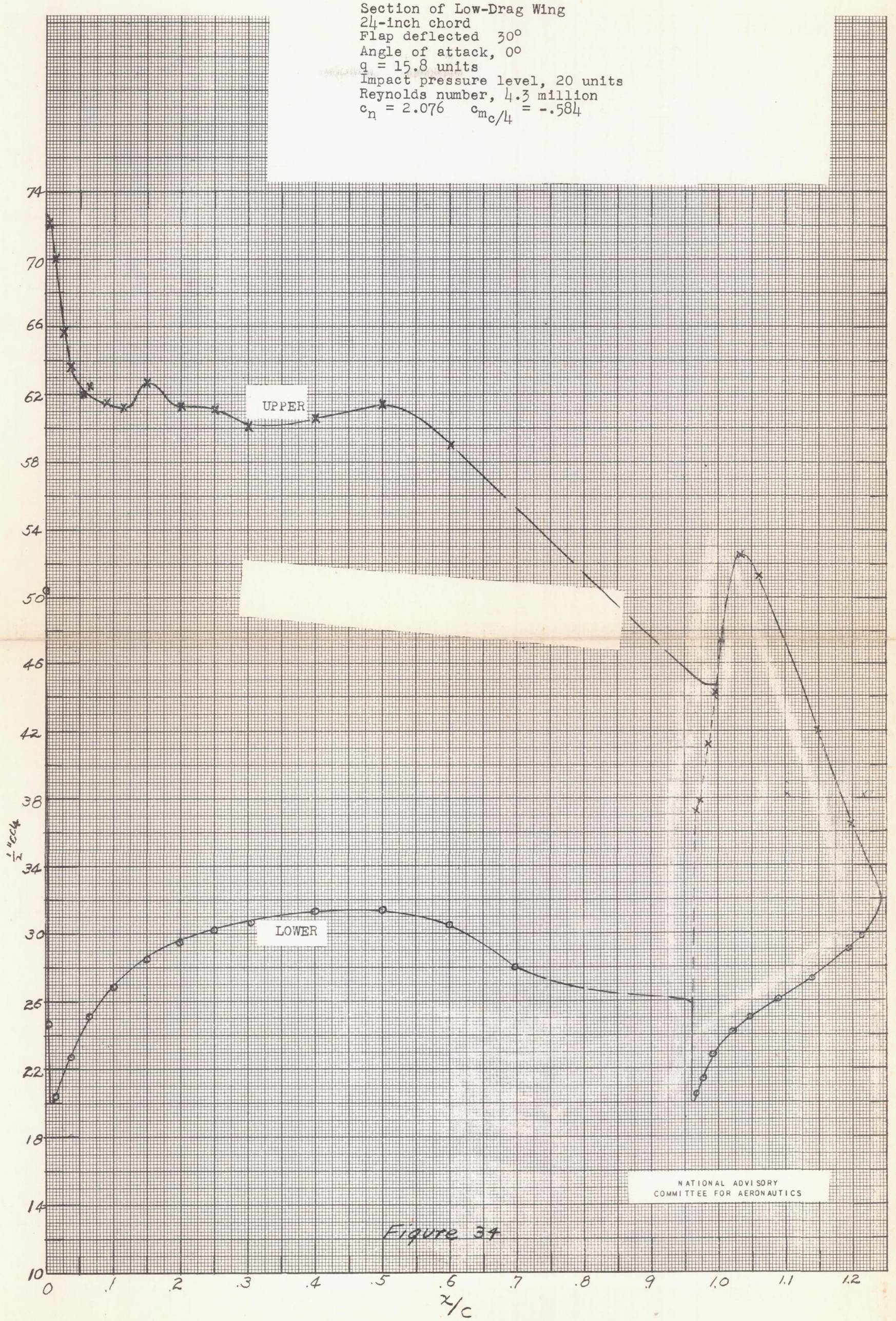

Figure 37

Section of Low-Drag Wing
24-inch chord
Flap deflected 30°
Angle of attack, 8.1°
q = 15.8 units
Impact pressure level, 20 units
Reynolds number, 4.3 million
c_n = 2.805 $c_{m_{c/4}}$ = -.543

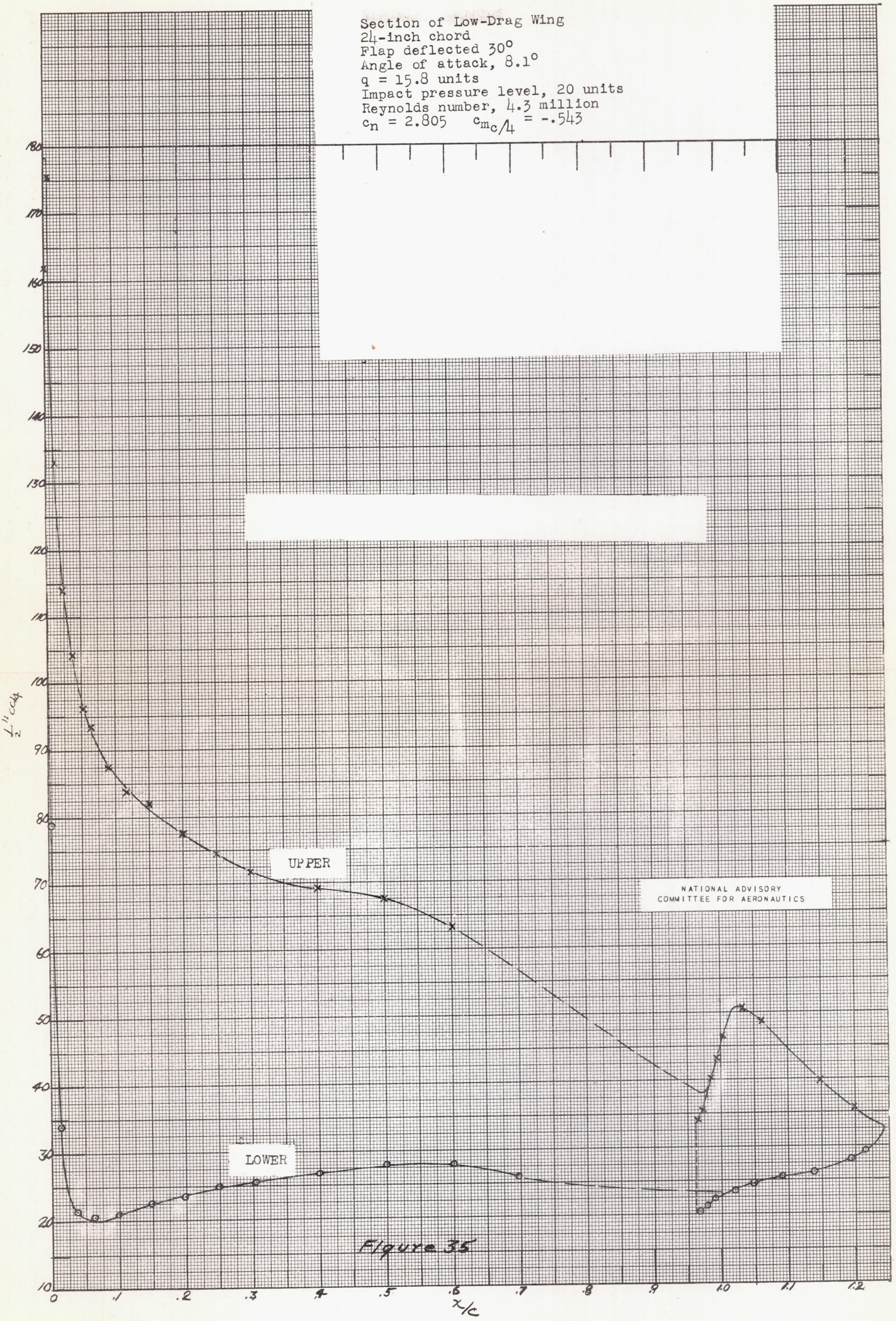

Figure 35